

# Muscular Variation in the Neck Region with Narrowing of the *Minor* and *Major Supraclavicular Fossa*

ORIGINAL

## Abstract

**Background:** The *sternocleidomastoideus* muscle is the most prominent landmarks of the surface anatomy of the neck, separates the anterior part of the neck (anterior triangle) from the posterior part of the neck (posterior triangle). An accessory head of *sternocleidomastoideus* muscle may cause complications while trying to access vital neurovascular structures that are located in the *minor* and *major supraclavicular fossa*. The purpose of this study is to describe an anatomical variation of the *sternocleidomastoideus* muscle and clinical impact.

**Methods and Findings:** The anatomical variations described were found during routine dissection conducted in the laboratory of Morphology of the University of Pamplona in two male cadavers of 47 and 75 years respectively. Measurements were taken using a Vernier caliper. Topographic details of the variations were examined, recorded and photographed. The morphological variations in the number of heads (three and four) of origin of *sternocleidomastoideus* muscle was found in two male subjects in right and left neck, bilaterally. The posterior cervical triangle was diminished. The bilateral narrowing of the *minor* and *major supraclavicular fossa* minimizing space needed for potential surgical access. The branching patterns of the spinal accessory nerve and arterial patterns were normal.

**Conclusions:** The Knowledge of the presence of additional heads of *sternocleidomastoideus* muscle it might cause difficulties in subclavian or *external jugular vein* catheterization, and in surgical interventions involving structures lying under the *sternocleidomastoideus* muscle. These variations must be kept in mind while approaching the region to avoid complications as the classical anatomical landmarks might be misinterpreted and confuse.

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## Keywords

Anatomical Variation, Clavicular Head, Sternal Head, *Minor Supraclavicular Fossa*, *Major Supraclavicular Fossa*, Additional Head, *Sternocleidomastoideus* Muscle, *Sternocleidomastoideus* Syndrome.

## Introduction

The muscles of the neck generate head movements and maintain the stability of the cervical spine; *Sternocleidomastoideus* (SCM) muscle plays a major part in it. The SCM muscle is one of the most complex in the body. It functions as a short range (clavicular head) and long range (sternal head) rotator, an upper cervical extensor, a flexor of the cervical spine on the thoracic spine, a lateral flexor, as well as a very important source of equilibrium [1,2]. In classic anatomical description, the sternal and clavicular portions of SCM muscle represent its origins, both the heads blends below the middle of the neck, leaving a changeable space in between them and the clavicular portion varies sufficiently in width. The muscle is inserted then in the lateral surface of the mastoid process and the lateral half or the two third part of the superior nuchal line, in the occipital bone [1].

The SCM muscle is responsible for the mechanical action in the majority of the head movements, is also considered an accessory muscle for respiration. The *sternocleidomastoideus* muscle is situated on the side of the neck. This thick muscle protects the great vessels, the branches of the cervical plexus, deep cervical lymph nodes and soft tissues from damage. The *sternocleidomastoideus* muscle is supplied by the spinal part of the accessory nerve. It also receives proprioceptive innervations by cervical spinal nerves from the cervical plexus [2]. The *sternocleidomastoideus* muscle receives its blood supply from branches of the occipital and posterior auricular arteries, which supply the upper part of the muscle. The muscular branches coming from the superior thyroid artery and suprascapular artery supply the middle and lower part of *sternocleidomastoideus* muscle [2-4]. The two heads of *sternocleidomastoideus* form with clavicle, the minor supraclavicular fossa. The major supraclavicular fossa is a larger depression behind the intermediate 3rd of the clavicle, between the lower parts of *trapezius* and *sternocleidomastoideus*. The *sternoclei-*

*domastoideus* functions as landmark for physicians, surgeons and anesthesiologists, who intervene in the *minor supraclavicular* and *major supraclavicular* fossa. The variability of *sternocleidomastoideus* anatomy may cause complications while trying to access vital structures located in the fossa [5]. Any variation in origin of *Sternocleidomastoideus* muscle can lead to narrowing of *minor supraclavicular* fossa, which can complicate *internal jugular vein*, *subclavian vein*, *external jugular vein* cannulation. A myocutaneous flap including an additional head of *sternocleidomastoideus* is of great use to the plastic surgeon because of its adequate vascularity and presence of sufficient tissue to be transferred to the recipient site [1-5]. The presence of supernumerary heads of SCM may affect the usual mechanism of a clavicle fracture and have a direct effect on bone fragments, diagnoses and treatment; malunion may impair these functions, in addition, callus formation or displacement can lead to thoracic outlet compression. The accessory SCM muscle could mimic pathological masses of the lateral neck region and can be confused with soft tissue masses such as lymphadenopathies; on clinical and imaging studies including metastatic disease, or benign tumors such as cyst, glomus tumor, neurofibroma, thrombosed vein, hematoma, familiar *sternocleidomastoideus* tumor of infancy, and hypertrophy of the SCM [2,6,7]. The objective of this study was to describe an anatomical variation of bilateral *sternocleidomastoideus* anatomy, the morphology features, the prevalence and clinical impact.

## Methods

This work was previously approved by the Ethics Committee in Research and Environmental Impact of the University of Pamplona, conformed by resolution 030 of January 16 of 2014 and Resolution No. 008430 of 1993 of October 4 of the Ministry of Health of Republic of Colombia by which regulates the scientific, technical and administrative norms

for health research. This descriptive cross-over study was designed to determine the prevalence, morphologic features and anatomical variations of the *sternocleidomastoideus* muscle. The region neck were studied serially during the years 2014-2016 in 15 male and 2 females embalmed adults cadavers in the laboratory of Morphology of the University of Pamplona. The anatomical variations described were found during routine dissection conducted in the laboratory of Morphology of the University of Pamplona in two male cadavers of 47 and 75 years respectively. Measurements were taken with assistance of a sliding Vernier caliper, accurate to 1 mm during the course of the anatomical dissection. The data thus obtained were recorded in a physical matrix and were consigned in digital media using Excel tables. Topographic details of the variations were examined, recorded and photographed.

## Results

The morphological variations in the number of heads of origin of *sternocleidomastoideus* muscle were observed in 2 out of 16 neck (11.76%). It was found in two male subjects in right and left neck, bilaterally. The remaining 15 neck (88.24%) showed the normal origin, insertion, course of the *sternocleidomastoideus* and the course and branching patterns of the spinal accessory nerve and arterial patterns was normal having classic branching.

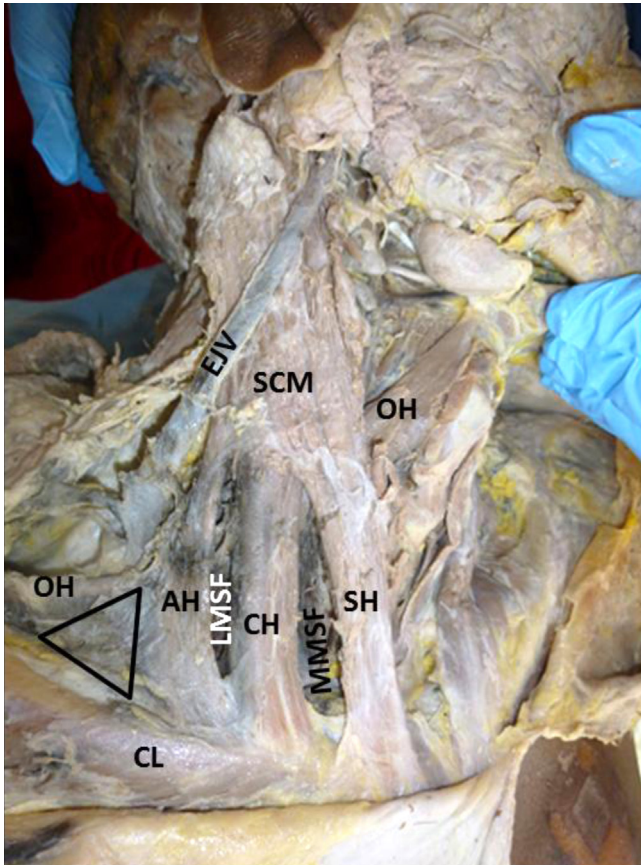
In the male cadaver of 47 years old in the right side, it was observed that the *sternocleidomastoideus* muscle has three heads, arising by a tendinous head from the front of the manubrium sterni and by a broad aponeurotic head from the medial part of the upper surface of clavicle, lateral to its medial end. Additionally, an unusual prominent and broad muscular slip was also arising from the upper surface of clavicle, lateral to its medial end. The fibers of both the clavicular heads were directed vertically upwards and backwards. The fibers of the usual or medial clavicular head were fusing with the sternal

fibers at a distance of 4.8 cm from the clavicle, while the distance of fusion of additional clavicular fibers with the usual clavicular fibers was 5.3 cm. The sternal, usual clavicular and additional clavicular heads were blending into a thick, rounded muscle belly which was inserted by a tendon onto the lateral surface of the mastoid process and the superior nuchal line of the occipital bone. Medial *minor supraclavicular* fossa: the depression was between 1st and 2nd heads, base about 1.5 cm and height of about 4.5 cms on either side. Internal jugular vein was found behind the second head. Lateral *minor supraclavicular* fossa: the depression was between 2nd and 3rd heads, base about 0.8 cm and height of about 3.6 cms on either side. Spinal accessory nerve was found between 1st and 3rd heads present superficially and 2nd head on its deeper aspect and supplied the three heads. The usual as well as the additional slip were supplied by a branch from the spinal part of the accessory nerve. The additional head received its blood supply from an independent branch of suprascapular artery (**Figure 1**).

In the same male cadaver of 47 years old, on the left side, instead of a normal *sternocleidomastoideus* (SCM), four muscle bellies were recorded, in terms of heads one sternal and three clavicular. The medial of the four heads had anatomy corresponding to the usual sternomastoid portion of the SCM. It was extended from the sternal manubrium to the mastoid process tip. The second head extending from the sternoclavicular joint, posterior and lateral to the origin of the sternomastoid muscle. The third muscle head originated from the lateral part of the proximal third of the clavicle and terminated at the occipital bone just inferior to the insertion of the sternomastoid head. A fourth muscle head, arose from the middle third of the clavicle, coursed upwards, posteriorly, and obliquely, in a parallel course to the previously described muscle bellies and fused with the third head muscle at the level of the middle third of the anterior border of the trapezoid muscle. The non-typical arrangement of the muscle



**Figure 1:** Superficial dissection of right side of the neck region showing three heads of *sternocleidomastoideus* muscle.

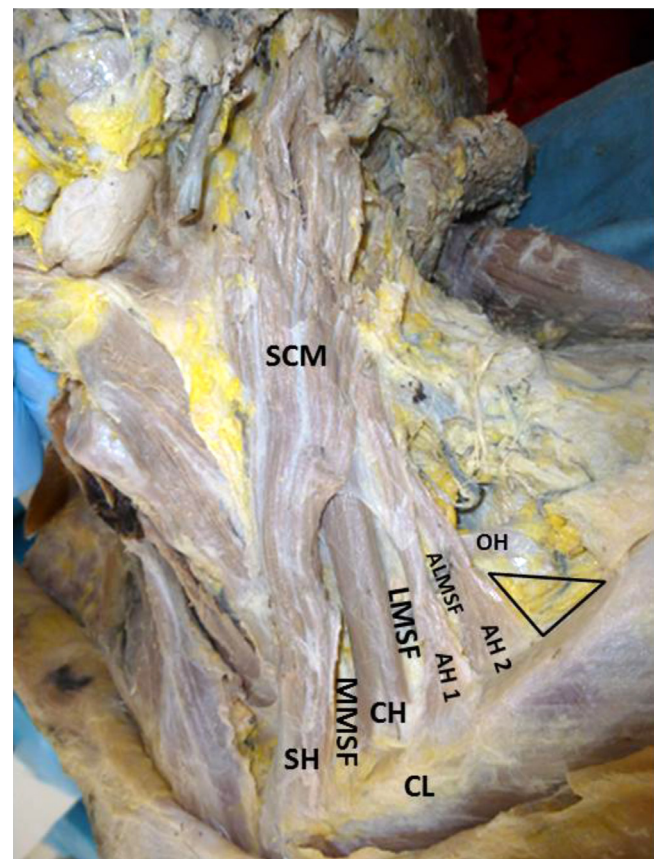


tendons on the left side of the neck created a very narrow minor supraclavicular fossa medially. Laterally, an even narrower additional minor supraclavicular fossa laterally and posterior cervical triangle was found, while the *major supraclavicular* fossa was shortened considerably. Medial *minor supraclavicular* fossa: the depression was between 1st and 2nd heads, base about 0.7 cm and height of about 4.5 cms on either side. Internal jugular vein was found in the triangle. Lateral minor supraclavicular fossa: the depression was between 2nd and 3rd heads, base about 0.7 cm and height of about 3.8 cms on either side. Additional Lateral *Minor supraclavicular* Fossa: the depression was between 3rd and 4th heads, base about 0.5 cm and height of about 3.0 cms on either side. Spinal accessory nerve was

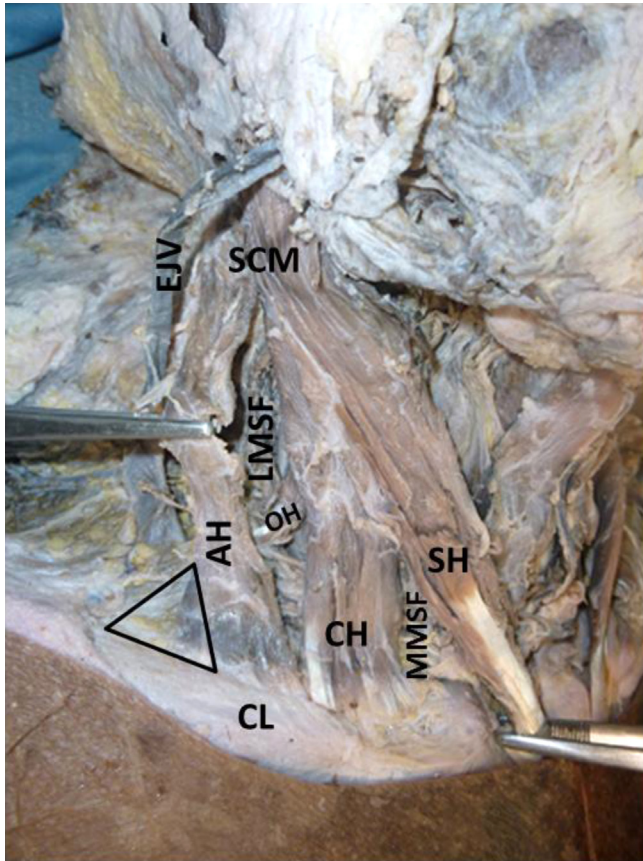
found between 1st and 3rd heads on the superficial aspect and 2nd and 4th heads on the deeper aspect and supplied the four heads. The additional head received its blood supply from an independent branch of suprascapular artery. (**Figure 2**).

The presence of third head or accessory head of *Sternocleidomastoideus* was observed bilaterally in a male cadaver of 75 years of age: Right *Sternocleidomastoideus*, it had three heads, sternal head had a rounded origin from anterior surface of the manubrium sterni, got inserted to the mastoid process and superior nuchal line of occipital bone. Clavicular head originated from superior surface of medial one third of clavicle. Before insertion it merged with deeper surface of the sternal head from clavicle and got attached to the mastoid and occiput deep to the sternal head. Additional head

**Figure 2:** Superficial dissection of left side of the neck region showing four heads of *sternocleidomastoideus* muscle.



**Figure 3:** Superficial dissection of right side of the neck region showing three heads of *sternocleidomastoideus* muscle.



which had its origin from superior surface of clavicle, 3.5 cms from the sternal end of clavicle about 0.7 cm wide, it merged with sternal head above the clavicular head at a distance of 3.8 cms from the clavicle, then it got attached to the superior nuchal line for insertion corresponding to the fibres of sternal head. At the fusion of the clavicular heads with the sternal head it was 2 cms wide. Medial *minor supraclavicular* fossa: the depression was between 1st and 2nd heads, base about 1.7 cm and height of about 2.2 cms on either side. *Internal jugular vein* was found behind the second head. Lateral *minor supraclavicular* fossa: the depression was between 2nd and 3rd heads, base about 0.8 cm and height of about 6.3 cms on either side. Spinal accessory nerve was found between 1st and 3rd heads present superficially and

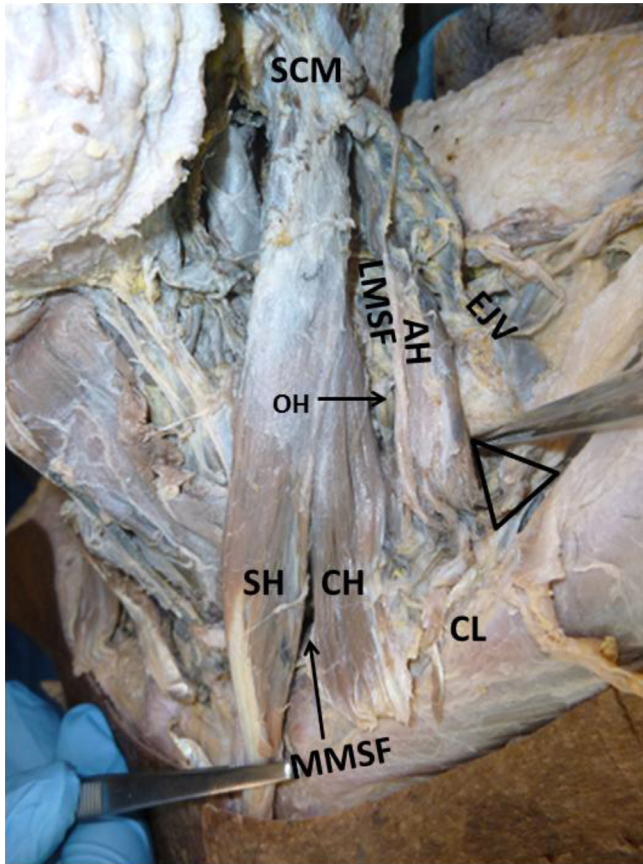
2nd head on its deeper aspect and supplied the three heads. Arterial patterns were normal having classic branching. **Figure 3.**

Left *Sternocleidomastoideus*, It had three heads. Sternal head origin was rounded from the anterior surface of the manubrium sterni, inserted to the mastoid process and superior nuchal line of occipital bone. Clavicular head originated from superior surface of medial one third of clavicle. Before insertion it merged with deeper surface of the sternal head and got attached to the mastoid and occiput deep to the sternal head. Additional head originated from superior surface of clavicle, 4 cms from the sternal end of clavicle. Before insertion it merged with sternal head above the clavicular head at about 6.5 cms from the clavicle, then it got attached to the superior nuchal line for insertion corresponding to the fibres of sternal head. Medial *minor supraclavicular* fossa: the depression was between 1st and 2nd heads, base about 0.5 cm and height of about 2.2 cms on either side. *Internal jugular vein* was found in the triangle. Lateral *minor supraclavicular* fossa: the depression was between 2nd and 3rd heads, base about 0.7 cm and height of about 6.3 cms on either side. All the normal and additional head of *sternocleidomastoideus* muscle found were covered by the investing layer of the cervical fascia, and were innervated mainly by the spinal accessory nerve. Arterial patterns were normal having classic branching. **Figure 4.**

The presence of additional heads of *sternocleidomastoideus* muscle in both sides reduced the gap between the *trapezius* and *sternocleidomastoideus* muscle. The non-typical arrangement of the muscle tendons on the right and left side of the neck created a very narrow *minor supraclavicular* fossa medially. Laterally, an even narrower additional *minor supraclavicular* fossa laterally and posterior cervical triangle was found, while the major supraclavicular fossa was shortened considerably.



**Figure 3:** Superficial dissection of left side of the neck region showing four heads of *sternocleidomastoideus* muscle.



## Discussions

The *sternocleidomastoideus* muscle (SCM) has been acknowledged from surgeons of the head and neck as a significant anatomical landmark of the anterior and lateral neck region while carries prominent interest for anesthetists. Equitably, it can be called as the “Pandora’s box”, as it provides coverage to many important deeper lying structures such as the accessory nerve, *brachial plexus*, cervical plexus nerves, carotid artery, *internal jugular vein*, and jugular chain lymph nodes [6]. The anterior and posterior rim of the SCM serves as the boundary for the division of each hemi-neck into the anterior and posterior cervical triangle respectively, whilst its two heads near their origin create the minor supraclavicular fossa. The SCM can be subdivided into super-

ficial and deep parts, while the amount of fusion between the two SCM heads varies considerably between subjects [7].

It originates and is attached inferiorly by two heads, medial sternal head which is rounded and tendinous; and lateral clavicular head. The sternal head originates from the upper part of the anterior surface of the manubrium sterni and ascends posterolaterally. The clavicular head is variable in width and contains muscular and fibrous elements, originates from the superior surface of the medial third of the clavicle and ascends almost vertically. The two heads of origin are separated near their attachments by a triangular interval, which corresponds to a surface depression, the *minor supraclavicular fossa*. As they ascend, the clavicular head spirals behind the sternal head and blends with its deep surface below the middle of the neck, forming a thick, rounded belly. The muscle is inserted superiorly by a strong tendon to the lateral surface of the mastoid process from its apex to its superior border, and by a thin aponeurosis into the lateral half of the superior nuchal line. The clavicular fibres are directed mainly to the mastoid process; the sternal fibres are more oblique and superficial, and extend to the occiput. The direction of pull of the two heads is therefore different, and the muscle may be classed as 'cruciate' and slightly 'spiralized' [2, 4, 8].

Variations in origin of both heads of *sternocleidomastoideus* muscle have been reported but variations in clavicular head are more common than sternal head. Usually the clavicular origin is narrower than the sternal head. When the clavicular origin is broad; it is subdivided into several slips separated by narrow intervals [9]. Embryology of developing human is a valuable asset in understanding anatomic variations. The *sternocleidomastoideus* and *trapezius* develop from a common pre-muscle mass from last two occipital and upper cervical myotomes. At 9 mm stage the common mass splits and separates. The two divisions grow independently along the upper limb bud. At 14 mm stage the mass destined to

form *sternocleidomastoideus* becomes fixed first to the clavicle and later to the sternum, occipital bone and mastoid process. When the clavicular origin is broad enough as much as 7.5 cm it is divided into several slips separated by narrow intervals. The additional slip in the clavicular origin can be due to the unusual splitting in the mesoderm of the post sixth branchial arch [9].

A sound knowledge of the irrigation and venous drainage of the head and neck, including possible variations of the *sternocleidomastoideus* muscle is essentially important for head and neck surgeons, radiologists and plastic surgeons [3, 10-12]. The awareness of such variations is also important during the MR imaging of the neck region. The additional head of the *sternocleidomastoideus* muscle can be used along with the portion of the clavicle to reconstruct the mandible to treat the mandibular defects and can also be used as a suture line to protect the carotid and innominate arteries [10]. Additional minor supraclavicular fossa between the accessory and clavicular heads should be kept in mind while approaching the *internal jugular vein* for venous catheterization. Since the additional belly observed in the present study arising from the fascia in the roof of subclavian triangle, it might interfere with invasive techniques, and it may also cause the difficulties in the surgeries in this region. Surgeons can make use of these additional slips as a myocutaneous flap, in the head and neck region without disturbing the normal morphology of the muscle [13].

The segments of the SCM may be utilized as a muscle or myocutaneous flap for the reconstruction of regional soft tissue defects after traumatic and oncologic head & neck procedures, thus rehabilitation of oral cavity defects, reanimation of the face, aiding in shoulder elevation, added. The preserved segments of the SCM prevent the possibility of significant drooping and limitation in shoulder-joint movements [7, 10]. Furthermore, the segments of the SCM can serve as anatomical landmarks in loca-

lization of the *minor* and *major supraclavicular fossa* for the effective cannulation of the *internal jugular vein* [7]. The presence of aberrant or supernumerary muscles in the lateral neck region can limit the access and make difficult the dissection of level IV and V cervical lymph nodes and neurovascular elements during a variety of surgical procedures [7, 10].

SCM has a keen role in the physiology of head – neck balance. It acts as a check rein to prevent the head from falling backwards. The clavicular division specially contributes to the sense of equilibrium. The head position is characteristic of the action of the SCM and is suggestive of contraction or shortening of the muscle; if involved. Significant spasm of the SCM can be seen and tenderness can be elicited in the body of the muscle in various medical conditions [6]. The SCM may develop myofascial trigger points in both heads. Trigger points are typically taut bands of muscle fibers and are “ropy” and sensitive to pressure when compressed. They can create a local twitch response or “jump sign”, which is due to involuntary contraction of muscle fibers. Trigger points usually occur longitudinally along the length of the muscle and are more common in postural axial muscles. The referred pain is often described as deep and dull. Compressing the trigger point will commonly elicit a consistent referral pain pattern. Trigger points can be classified as active or latent, with the former causing constant pain and the latter “silent” until aggravated [14]. The clavicular division of SCM trigger points can produce pain over the forehead and around the ipsilateral eye, over the cheek, the tip of the chin, sternoclavicular joint and deep in the throat upon swallowing. The clavicular division of SCM has also been documented to play an important role in the sense of equilibrium. The sternal trigger points can cause pain over the ipsilateral and bilateral forehead, inside and behind the ear. The sternal head trigger points may further produce autonomic disturbances, such as excessive lacrimation, conjunctivitis, rhinitis, blurred vision, coryza and ipsilateral eyelid droops – most likely due

to spasm of the orbicularis oculi muscle. The condition is referred to as the “*Sternocleidomastoideus* syndrome”. Both the clavicular and sternal divisions of SCM produce referred pain (including facial pain and dizziness) if activated [6, 14].

## Conclusion

The *sternocleidomastoideus* muscle (SCM) functions as a landmark are important not only for the anatomist but also for physicians such as anaesthesiologists, general surgeons, orthopaedic surgeons, neurosurgeons, head and neck surgeons, radiologist, interventional radiologists, plastic surgeons, oral surgeons, maxillofacial surgeons, oncologists, physical therapy, physiatrists, physiotherapists, in electrophysiological studies, chiropractors. A sound knowledge of possible variations of SCM is essentially important in the clinical examination and surgical procedures of the head and neck region.

## Abbreviations

SCM: Sternocleidomastoideus Muscle; SH: Sternal Head; CH: Clavicular Head, AH: Additional Head; OH: Omohyoid Muscle; MMSF: Medial Minor Supraclavicular Fossa; LMSF: Lateral Minor Supraclavicular Fossa; CL: Clavicle; EJV: External Jugular Vein; Triangle: Major Supraclavicular Fossa (Omoclavicular Triangle, Subclavian Triangle). AH 1: Additional Head; AH 2: Additional Head; ALMSF: Additional Lateral Minor Supraclavicular Fossa; Triangle: Major Supraclavicular Fossae (Omoclavicular triangle, Subclavian triangle).

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family, or persons responsible for their care, process subject to compliance with the legal regulations in the Republic of Colombia.

## Competing interests

None.

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